not to be considered as unimportant from an economic point of view. The most interesting opportunity for studying the acid series is afforded by the isolated peaks west of the Magdalena range proper, as in Magdalena and Elephant mountains which are parts of the great flows above indicated.

The large mountains forming the nucleus of the range, preeminently Big Baldy and Timber peaks, are also volcanic, and although capped with acid rock, occupy the place of an old andesite eruption. The latter occupies the east side of the main range southwest of the cliffs of Water cañon, and forms the country rock in which the gold segregation has occurred.

It is perhaps of more geological than economic interest to determine the age of the dykes of acid matter which, by intersecting the andesite, have provided the conditions for ore concentration in this district. The results of a brief study of the field seem to suggest that the acid intrusives are of the same age as the later flows above described. The gold seems, however, to be derived from the andesite so that the ore is chiefly in selvages or brecciated margins rather than uniformly distributed in the quartz. A thorough petrographic study of the region has been begun but would not be admissible here.

Enough has been said to indicate that a careful geological survey of the region would have important bearings on the economic development of the mineral resources.

Throughout the entire region so far as studied, there is no important exception to the rule that gold is segregated along contacts of acid rocks with basic intrusives or the converse. Andesite is preëminently the gold-bearing country rock.

VALLEY GLACIERS OF THE UPPER NUGSUAK PENINSULA, GREENLAND.

By Ralph S. Tarr, Ithaca, N. Y.

Valley Glaciers of Greenland. Passing along the Greenland coast, one is almost constantly in sight of valley glaciers. Some of these are tongues from the great ice cap, but many are furnished with their supply from local snow fields. These are particularly abundant in the Vaigat straits and in Umenak fjord Here one sees every gradation between the large, well defined glacier, terminating in the sea, and mere snow banks.

Fig. 1.—The sea terminus of Nugsuak glacier.

Fig. 2—A dying glacier. Upper Nugsuak peninsula.

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The glaciers seen on the west side of Vaigat strait are furnished with their supply from the local ice cap, which overspreads the most of Disco island. In the neighborhood of Godhaven, the ice cap is easily reached by a climb of 2,500 feet, and at this point is found to possess an attenuated edge. In going from the land to the ice, one passes over patches of snow, then, almost imperceptibly, attains the ice cap edge without steep ascent. This is entirely different from the edge of the main ice cap which, everywhere that I saw it, presents a distinct slope, and oftentimes a precipice toward the land. Near the middle of August the surface of this attenuated edge was wet and slush-covered, with innumerable streams flowing over its surface. Even at a considerable distance from the margin, and at an elevation of 3,200 feet similar conditions exist.

Time did not permit extensive exploration of this ice cap, but viewed from a high place (about 3,200 feet above sea level) it was seen to extend many miles toward the interior of Disco island, with a very irregular surface, evidently conforming to variations in the under topography. Along the margin, where we approached the glacier, there was no evidence of motion, but every appearance of nearly perfect stagnation. Descending from this place, which was a divide, toward the valley on either side, evidence of motion was found in the crevasses which break the surface of the ice cap. Passing down one of these valleys, it is found that the ice projects as a valley tongue; and in the case of the larger valley, as a distinct glacier. On the margin of one of these valleys the ice cap comes to the edge, in some places forming a precipice, in other places hanging down over the edge of the cliff as a hanging glacier.

In several of the valleys visited by different parties, evidence of former greater ice extension was found in the presence of moraines, both marginal and terminal, beyond the present ice margin. Another notable feature of the glacial geology of this island, was the presence of gneissic boulders stranded upon the trap rock which forms the cap of this part of Disco. These boulders extend all the way up to the edge of the ice. Whether they were brought to their places by the glacier, at some time when Disco island was more extensively ice

covered, and brought from within the island itself, or whether they were brought to their present places by a more general ice sheet, reaching out from the mainland, was not determined. No doubt a study of the bed rock on the mainland, and a comparison with the transported boulders will decide this point. From what I saw farther north, I am inclined to believe the latter the more probable explanation.

The Looped Glacier of the Upper Nugsuak Peninsula. In the Upper Nugsuak there is no *general* ice covering at present;* but there are numerous glaciers of various sizes, resembling in many respects those that were seen further south. The largest valley glaciers of this peninsula were located on the northern or sheltered side, and in the inland valleys, at the base of a high mountain which reached from 2,500 to 3,000 feet above the sea. In such an interior valley, near the middle of the peninsula, a glacier descends toward the interior from the extensive snow fields, which also supply another glacier, described later as the Nugsuak glacier. The tongue which descends toward the interior was call the Looped glacier, because of the outline of its margin. It is a hanging glacier, descending from the edge of a low part of the valley wall. In some portions the looped edge is attenuated, and ends in melting ice, with no sign of movement, and no distinct moraine. In the main and northern loop, the ice assumes the condition of a true valley glacier, whose surface is roughened by crevasses and by melting. Its terminus is a precipice, and its base is lined by morainal debris. In the lower layers of this tongue there are distinct dirt bands and many boulders. The glacier presents no specially remarkable features, and is merely mentioned to illustrate one of the conditions of glaciation at present existing on the Nugsuak peninsula.

The Nugsuak Glacier (Fig. 1). From the same snow field as that which furnished the ice for the Looped glacier, there descends, from an elevation of probably not less than 2,000 feet, a distinct tongue of ice, the most notable valley glacier on the

*This peninsula is in latitude 74 deg. 10-15 min., and was the place selected for study by the Cornell party which accompanied Lieut. Peary in the Greenland Expedition in 1896. Besides myself the members of the party were Prof. A. C. Gill, and Messrs. J. O. Martin, T. L. Watson, E. M. Kindle and J. A. Bonsteel. To all of these men I am indebted for valuable aid in my studies.

peninsula. Its valley walls are steep on the eastern side, and only moderately steep on the western side. There are no distinct marginal moraines, although at places accumulations of debris extend to the edge and top of the ice. This glacier, which discharges the greater part of the surplus of snow in the snow fields of this place, is now just able to reach the sea. In one place the ice front is bathed by the waters of the fjord; but the greater part of the front, which is about 250 yards in extent, is terminated by a small marginal lake, or else by moraine upon the land.

The lake, which is moraine dammed on the seaward side, stands at an elevation of about five feet above high tide. The moraine at the terminus is very bouldery, and in some places rests upon an ice foot, forming a thin film. However, in the part where the dam of the lake is built, the moraine is situated in a place entirely distinct from the glacier itself, as if marking the recent retreat of the ice. The front of this valley glacier is steep, rising 50 or 60 feet, with an average angle of about 50°-60°, and in its base there are layers of dirt and boulders, some of the latter weighing two or three tons.

Dying Glaciers (Fig. 2). Besides these two valley glaciers, and one that was not studied, but which exists to the east of these two, there are many tiny accumulations of ice, which in some cases are distinct glaciers, in others apparently nothing more than snow banks. Among these there are banks of snow, or rather of ice compacted from the winter snow, which are not in movement, but merely remain from year to year. The depth of these may in some cases be 20 or 30 feet. There are other banks however, in which one finds lines parallel to the outline of the bed, and in the base of which are layers of dirt. Among these there are many that are crevassed on the surface, showing distinct movement, but no snow fields exist to supply the glacier. From an examination of a large number of these, I have no hesitation in affirming, that upon the upper Nugsuak peninsula one can find every gradation from the snow bank that is motionless, to the distinct valley glacier tongues supplied from snow fields.

Former Greater Extension. These small glaciers are called *dying glaciers*, and in this category may also be included the larger Looped and Nugsuak glaciers described above, although

their death is not so near at hand. That these are not newly born glaciers, now expanding and increasing their range, is proved by the observations that were made in their neighborhood. Below some of these tiny snow-bank glaciers there were abundant transported boulders, resting upon bed rock which was striated. They had evidently been brought to their place by the glacier at some time when it was more extensive than at present. In all cases the striæ pointed toward the present glacier remnants, and showed the intimate connection between the direction of the ice movement and local topography. For instance, in the valley where the Looped glacier now ends, the striæ, which are very fresh, point towards the sides of the valley. Near the middle of the valley, and in the center, they extend down grade toward the sea on the northern side of the peninsula.

The same evidence of former extension of local ice sheets was seen near the margin of the Nugsuak glacier, where the rock near the front is striated by fresh grooves, and the rock surface is not covered by lichens, even in the smallest degree. There is every evidence that the ice here, on the northern side, and in the central parts of the Nugsuak peninsula, has very recently reached further than at present, and that the valleys have been filled by glaciers furnished from several snow fields. Several valley tongues have joined to form a single glacier, which has moved toward the north.

This evidence is in perfect harmony with that found along the margin of the continental ice sheet near by, as is described in another article. This sheet of ice is now retreating, and moraines recently abandoned are seen along its margin. Before this the ice of the continental glacier reached out beyond the outermost limits of the peninsula, involving the whole land in general glaciation, with the direction of movement from the east. This was succeeded by local glaciation, similar to that at present noticed in the ice cap of Disco, though less universal, partly because of the smaller land area, and partly because of the more irregular topography. During this time the ice movements were in various directions, and the transportation of fragments and the striation of rocks was in accord with the minor details of topography. The ice then moved in northerly, easterly, southerly and westerly direc-

tions, though the longest and most universal movement was the first, toward the west. Probably before the general ice covering, there was a stage of local valley glaciers, of newly born glaciers similar to those now dying. This more continuous glaciation, in the interior and shaded northern parts of the peninsula, has impressed itself upon the topography of the inland valleys in the form of much rounded roches moutonnées hills and rounded rock areas of smaller size. There is also a marked contrast between the fresh rock surface and the rounded appearance of the bottoms of these valleys and the more angular hill sides and hill tops which have been longer exposed.

Now most of these glaciers have disappeared, the largest being the Looped and Nugsuak glaciers, furnished from the same snow field. Even these are diminishing in size and many of the tongues which joined with them to form larger glaciers, are now present either in the form of nearly motionless glaciers, without snow fields, or else in the form of ice patches and snow banks, in the shady, protected valleys and mountain passes.

LAKES WITH MORE THAN ONE OUTLET.

By Thomas L. Watson, Ithaca, N. Y.*

The possibility of a lake basin having more than one outlet or overflow channel through which it drains has caused more or less discussion since the early sixties. The controversy first had its origin, so far as known to the writer, about some Norwegian lakes, but one which was especially significant at the time and caused considerable comment, was Lake Victoria-Nyanza. It was then given as the head-waters of the River Nile† and described as having three outlets. These, with other lakes, were described in the Athenæum‡ of London, and the controversy lasted from 1863 through 1866. This was follow-

*This essay is intended to represent a brief summary of the work done on lakes with more than one outlet, and citation of references to the literature, with a short description of several lakes of this kind noted by the writer during the past summer.

†Athenæum, 1863, vol. I, pp. 843-845.
Ibid., 1864, vol. I, p. 164.
Ibid., 1865, vol. II, p. 121.
Ibid., 1866, vol. I, pp. 367, 499, 564-565.

‡Athenæum (London)-1863, vol. II, pp. 19, 51, 113-114, 251-252, 578, 616, 652, 687-688, 718-719, 829-832, 838.